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NASA

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NEWLY IDENTIFIED RESONANCE LINES OF Ni xix, Cu xx and Zn xxi

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ABSTRACT

Using a grazing incidence spectrometer and a low inductance condensed spark source, the authors have observed spectra of Ni xix, Cu xx and Zn xxi. By extrapolating the known data of the Ne i isoelectronic sequence, the new lines have been identified as belonging to transition arrays between the ground level $2s^2 2p^6\ ^1S_0$ and the following electronic configurations: $2s^2 2p^5 3s$, $2s^2 2p^5 3d$, and $2s2p^6 3p$. Some of these lines maybe emitted from the solar corona.

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Lines classified as belonging to the Ne I isoelectronic sequence have been reported for ions up to Co XVIII for the following transition arrays: $2s^2 2p^5 3s,3d$, 4d and $2s2p^6 3p$ to the ground level $2s^2 2p^6\ ^1S_o$ (Tyren 1938). We have recorded and identified lines of nickel (Ni), copper (Cu), and zinc (Zn) as belonging to this isoelectronic sequence.

The sources used was a vacuum spark chamber with electrodes made of the elements under investigation. The low inductance discharge circuit consisted of a 14 μF capacitor charged to 12 kV, and triggered by the discharge of a tesla coil placed near the ground electrode. The spectra were recorded on Kodak SWR glass plates, using a modified Jarrell-Ash 3-meter, 88 degree angle of incidence, spectrometer. The grating was a Bausch and Lomb gold replica having 1200 lines per mm, and blazed at $2^{\circ}35'$. To eliminate excessive background fogging of the plates in this range of wavelengths, aluminum and formvar filters each of about 2000 Å thickness were placed between the grating and the entrance slit.

With this equipment it was possible to record lines of Ni, Cu, and Zn between 10Å and 14Å. Most of the lines of the observed spectra appeared in the second order, enabling us to determine their wavelengths by comparison with the known lines of C V, O VII and Fe XVII. By plotting the known data of the Ne I isoelectronic sequence and extrapolating to the elements Ni, Cu, and Zn (Fig. 1) we have been able to identify the lines (Table 1). The lines belong to transitions between

Figure 1: Reduced energy level diagram ν/ζ vs. ζ of the Ne I isoelectronic sequence, where ν is the wave number in cm^{-1} and ζ is the spectrum number.

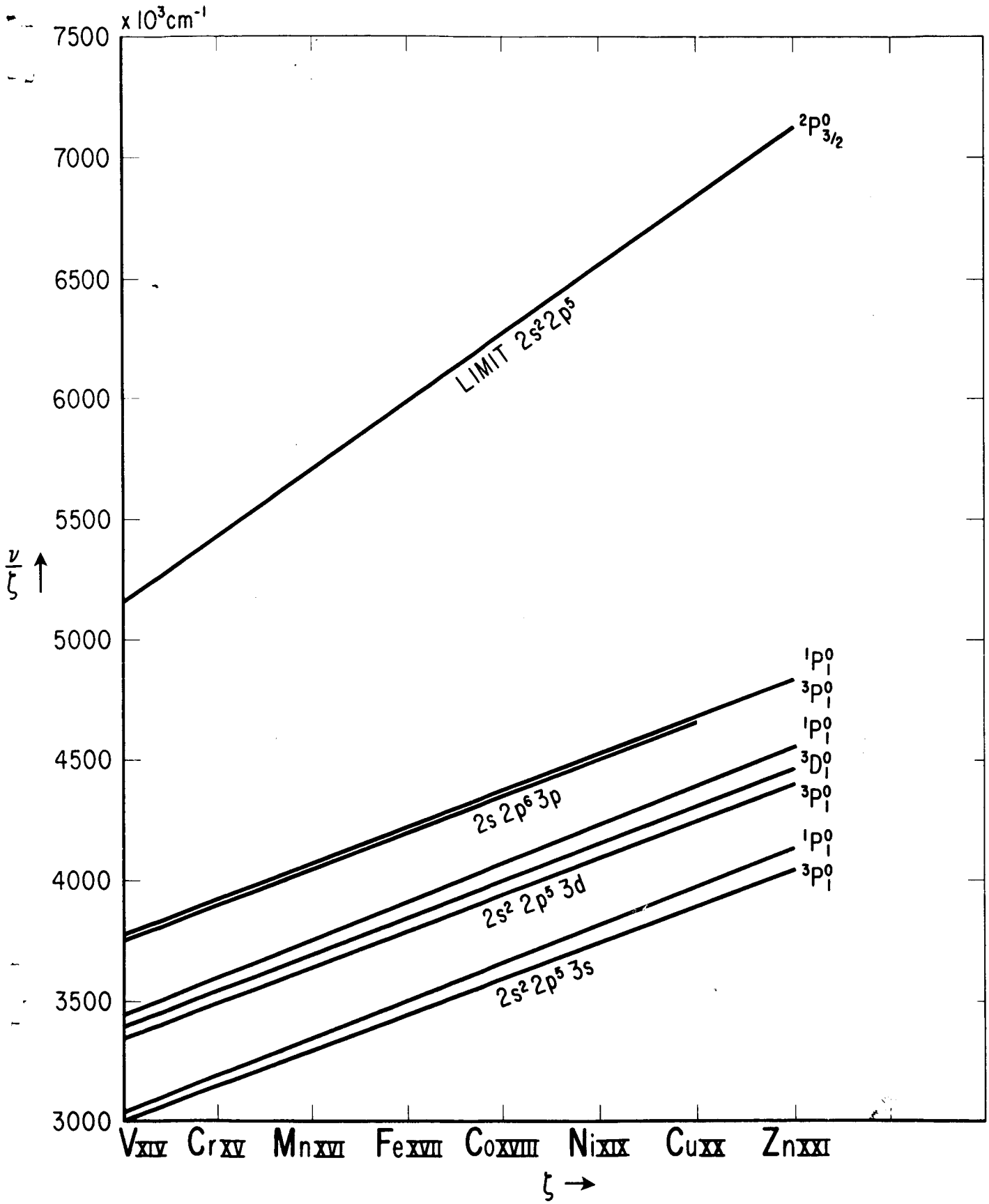

Table 1. Classification of lines from the $2s^2 2p^6$ - $2s^2 2p^5 3s,3d$ and $2s^2 2p^6$ - $2s 2p^6 3p$ transitions of Ni XIX Cu XX and Zn XXI

Transition	Ni XIX			Cu XX			Zn XXI		
	λ(Å)	Int	ν(cm^{-1})	λ(Å)	Int	ν(cm^{-1})	λ(Å)	Int	ν(cm^{-1})
$2s^2 2p^6\ ^1S_o$ - $2s^2 2p^5 3s\ ^3P^o_1$	14.03	6	7128000	12.82	6	7800000	11.76	6	8503000
" - $2s^2 2p^5 3s\ ^1P^o_1$	13.77	4	7262000	12.56	4	7962000	11.51	4	8688000
" - $2s^2 2p^5 3d\ ^3P^o_1$	12.80	2	7813000	11.73	2	8525000	10.80	2	9259000
" - $2s^2 2p^5 3d\ ^3D^o_1$	12.64	4	7911000	11.60	4	8621000	10.67	4	9372000
" - $2s^2 2p^5 3d\ ^1P^o_1$	12.42	6	8052000	11.38	6	8787000	10.47	6	9551000
" - $2s 2p^6 3p\ ^3P^o_1$	11.59	0	8628000	10.65	0	9390000			
" - $2s 2p^6 3p\ ^1P^o_1$	11.53	1	8673000	10.60	1	9434000	9.77	0	10235000

the three electronic configurations $2s^2 2p^5 3s$, $2s^2 2p^5 3d$, $2s2p^6 3p$ and the ground level $2s^2 2p^6\ ^1S_0$. Wavelengths, wave numbers, and visual intensities of the new lines are given in Table 1. In Table 2 are given the term values and the $2s^2 2p^5\ ^2P^o_{3/2}$ limit. We have used LS coupling designations because for these stages of ionization the configurations are far from pair coupling, unlike neutral Ne (Kastner et al. 1966).

The relatively high abundance of nickel in the sun gives us reason to believe that some of the intense lines of Ni XIX may exist in the solar corona.

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Table 2 Energy scheme for terms in Ni xix Cu xx and Zn xxi

CONFIGURATION	DESIGNATION	J	Ni xix(cm^{-1})	Cu xx(cm^{-1})	Zn xxi(cm^{-1})
$2s^2\ 2p^6$	$3p^6\ {}^1S_0$	0	0	0	0
$2s^2\ 2p^5\ 3s$	$3s^3\ P_1^o$	1	7128000	7800000	8503000
$2s^2\ 2p^5\ 3s$	$3s\ {}^1P_1^o$	1	7262000	7962000	8688000
$2s^2\ 2p^5\ 3d$	$3d\ {}^3P_1^o$	1	7813000	8525000	9259000
$2s^2\ 2p^5\ 3d$	$3d\ {}^3D_1^o$	1	7911000	8621000	9372000
$2s^2\ 2p^5\ 3d$	$3d\ {}^1P_1^o$	1	8052000	8787000	9551000
$2s\ 2p^6\ 3p$	$3p\ {}^3P_1^o$	1	8628000	9390000	
$2s\ 2p^6\ 3p$	$3p\ {}^1P_1^o$	1	8673000	9434000	10235000
Limit $2s^2\ 2p^5\ {}^2P^o_{3/2}$			12477000	13695000	14969000

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